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The Key Success Factor of Geographic Information System Re-implementation in Tenaga Nasional Berhad Distribution, Malaysia: A Case Study of Cheras Tenaga Nasional Berhad Distribution Station

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ABSTRACT

Tenaga Nasional Berhad (TNB) Distribution has embarked on the development of a Geographical Information System (GIS) since the year 2009. The scope of work is to map and digitize all TNB distribution electrical assets and to systematically establish the customer's database. In this study, a review on the GIS implementation was carried out at Cheras TNB Distribution station. The low utilization of GIS contributes the most to the need of having the GIS reviewed. The aim of the study is to develop a revised strategy for a successful GIS re-implementation in TNB Distribution electrical network based on the results from the review process. Its objectives are to develop and evaluate strategize plan for the re-implementation based on GIS components after reviewing and analysing the existing implementation. Key success factor (KSF) is introduced to deliver a success GIS project re-implementation. Data from previous implementation, survey, workshop and feedback from user of TNB Cheras staff are used for references when developing the strategies. GIS components are capitalized to establish KSF criteria in order to measure the successfulness of the re-implementation. System Usability Scale (SUS) is used for interpreting the KSF outcome. The study is finally ended with the development and evaluation of the proposed strategize plan for the re-implementation of four GIS components which are System and Tools, Data, Business Process and User. The proposed strategy is used to determine the effectiveness of the re-implementation strategies and KSF in order to drive the future invasion of GIS application to other TNB Distribution stations in Malaysia.

Keywords: Geographical Information System (GIS), Key Success Factor (KSF), Re-implementation, System Usability Scale (SUS)

1. Introduction

Tenaga Nasional Berhad is the largest electric utility company in Malaysia and also the largest power company in Southeast Asia as declared from TNB website dated December 2016. TNB's core activities are in the generation, transmission and distribution of electricity. This case study is implemented in TNB Distribution Division. The statistic in Table 1 shared the asset number of TNB Distribution Cheras station in April 2018. TNB Cheras is one out of 110 stations in TNB Distribution and the asset is maintained by TNB Distribution Network.

Table 1 Asset Statistic of TNB Distribution Cheras

Cheras TNB Distribution Asset Statistic	
Substations (numbers)	1248
Cable (KM)	4,598.128
Streetlights (number)	11,407
Customer Meters (numbers)	142,133

Current business needs and TNB's going towards Grid of the Future (GoTF) has led to Asset Management transformation by embarking into GIS in year 2009. The GIS software used for digitizing all the Distribution Network asset until customer meter point is GE Smallworld version 4.1.2.TNB Cheras station was one of the selected stations for the earlier implementation.

An assessment and review of the overall implementation of GIS took place in year 2014. This assessment was also influenced by low utilization of GIS usage in the stations. From TNB CGIS Project Review Documents dated in 2014, the outcome of the assessment resulted in re-implementation of GIS with a revised strategy taking into account gaps to be addressed and current technological landscape. Cheras TNB Distribution station has been chosen to be a case study and successful re-implementation of GIS at Cheras is the pre-requisite to further rollout nationwide. Therefore, Key Success Factors (KSF) are identified in order to measure the outcome of the strategize re-implementation and System Usability Scale (SUS) is used to interpret the KSF measurement result.

2. Problems of GIS Implementation in TNB Distribution

Figure 1 shows the electricity network map of Cheras taken from GIS database. For the case study, the scope of works is to re-implement the reviewed GIS functions that has been developed and deployed for usage at Cheras station through focusing on four GIS components which are **System and Tools, Data, Business Process** and **User**.

The purpose of the functions activities is to capture new and delta (change) data. These functions are able to reduce TNB Cheras network data gap. The execution of these functions are by embedding them into the normal daily work process.

The developed GIS functions are:

1. Asset Register
2. Supply New Connection and Reconnection
3. Project Planning & Wayleave Planning and Construction Project
4. Customer Service Support

The methodology of acquiring data used to review the implemented GIS are from existing database in GIS Smallworld from year 2009 to 2014 and other documents e.g. Functional Requirement Reports of the functions, TNB's 10 years GIS Master Plan, TNB CGIS Project Implementation Review Report 2014, Survey Report and etc. for further investigation and analysis.

2.1 System and Tools

TNB Distribution implementation architecture was a very simple setup that was tied too closely to a desktop system that was fairly complex to use and difficult to manage. Figure 2 shared the Implemented GIS framework with SOA (Service Orientated Architecture) as Enterprise Bus for integration medium. There has been integration between GIS with SCADA (Supervisory Control and Data Acquisition), SAP ERMS (Enterprise Resource Management System) and others but the performance was poor and not up to user requirement. Cico et al., (2015) agreed that improper interfaces in software architecture will lead to un-capability of maintaining the integration as well as editing same data through different system may affect integrity and consistency of data.

There are other pain points experienced by user that can be strategized for improvement. Referring to TNB CGIS Project Review Documents dated in 2014 the system performance in terms of login sometime took longer time i.e. about 90 seconds and unsatisfactory average response time of about 10 seconds. The GPS coordinates collected cannot be auto upload into Smallworld. It has to be digitized manually. Single platform was recommended earlier because of GIS in TNB was

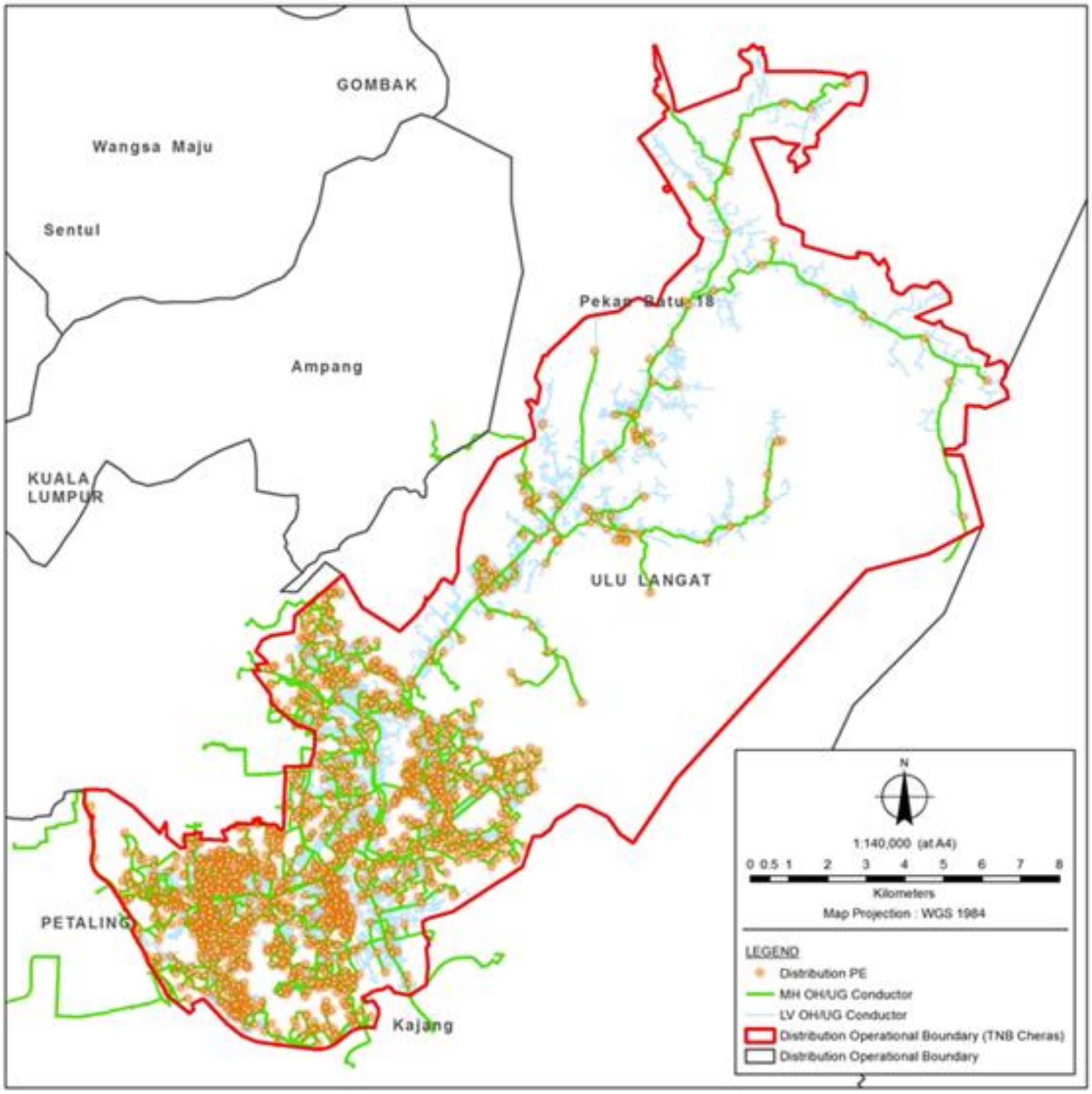

Figure 1 Asset and Network Map of TNB Cheras

silos. Each division or department doing their own thing. Unfortunately, single platform was a failure in TNB. Using one solution or technology will not solve the problems. In order to control silos, GIS framework and data governance were introduced. This allowed people to use technology that best suits their needs but still having some measure of control.

Earlier implemented GIS has accessibilities issues and system issue like data corrupt due to changes in the data model by other divisions, data lost and trace back errors due to incompetency in GE Smallworld by the users, GIS Project Teams, GIS Consultant and System Implementer (SI). Therefore, Subject Matter Expert (SME) in GE Smallworld is important for the re-implementation of GIS.

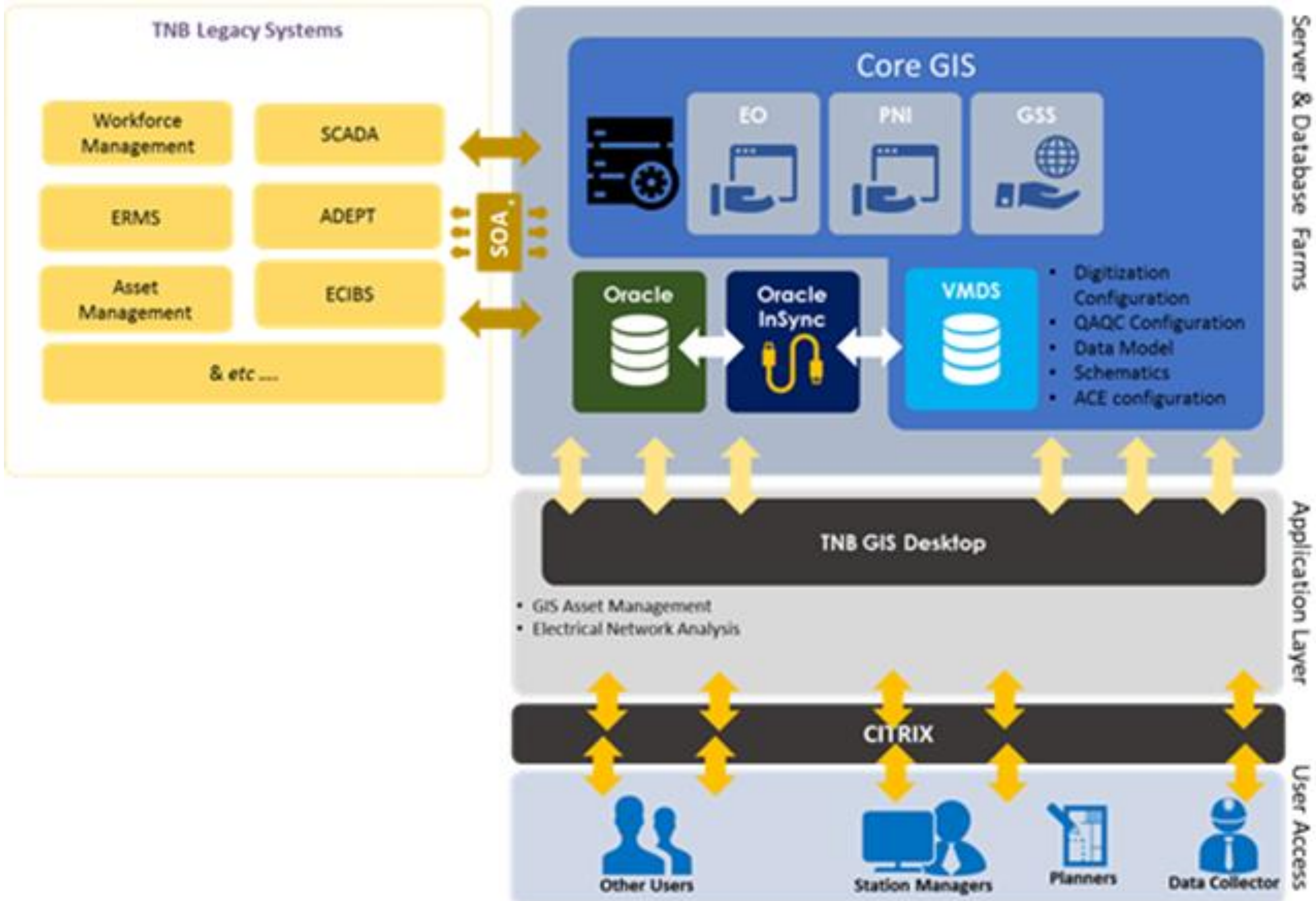

Figure 2 Implemented GIS Framework in TNB Distribution

2.2 Data

At distribution level, the network asset for data production starts at 33kV up to customer level as shown in Figure 3. Selected assets and networks as well as customers are collected to establish TNB Distribution GIS Electricity Network.

Data plays a major role in the success of the GIS system. The cost of building and maintaining the GIS database is typically 70% of the total GIS investment (Meehan, 2013). Approximately 80% of the duration of many large scale GIS projects deals with data input and management (Ian et al., 2006).

Data model definition acts as a starting point for data collection process. Hence, we should ensure that the data model matches the user and the system needs. Tomlinson (2013), agreed that user must know what they want through getting information from GIS, only than the desired data and attributes can be collected and model into GIS. The current data model is inconsistent, and it needs to be remodelled.

The data production consists of existing data, new data and delta data. All type of attributes or non-spatial data has been collected leading to huge effort, longer collection time and huge spatial database with insignificant impact and software limitation in processing the information. Thus, GIS database became heavy and reduce processing speed. This statement is supported by Shamsi (2004), where network simplification process or "skeletonization" is chosen by modellers to increase processing speed without compromising model accuracy.

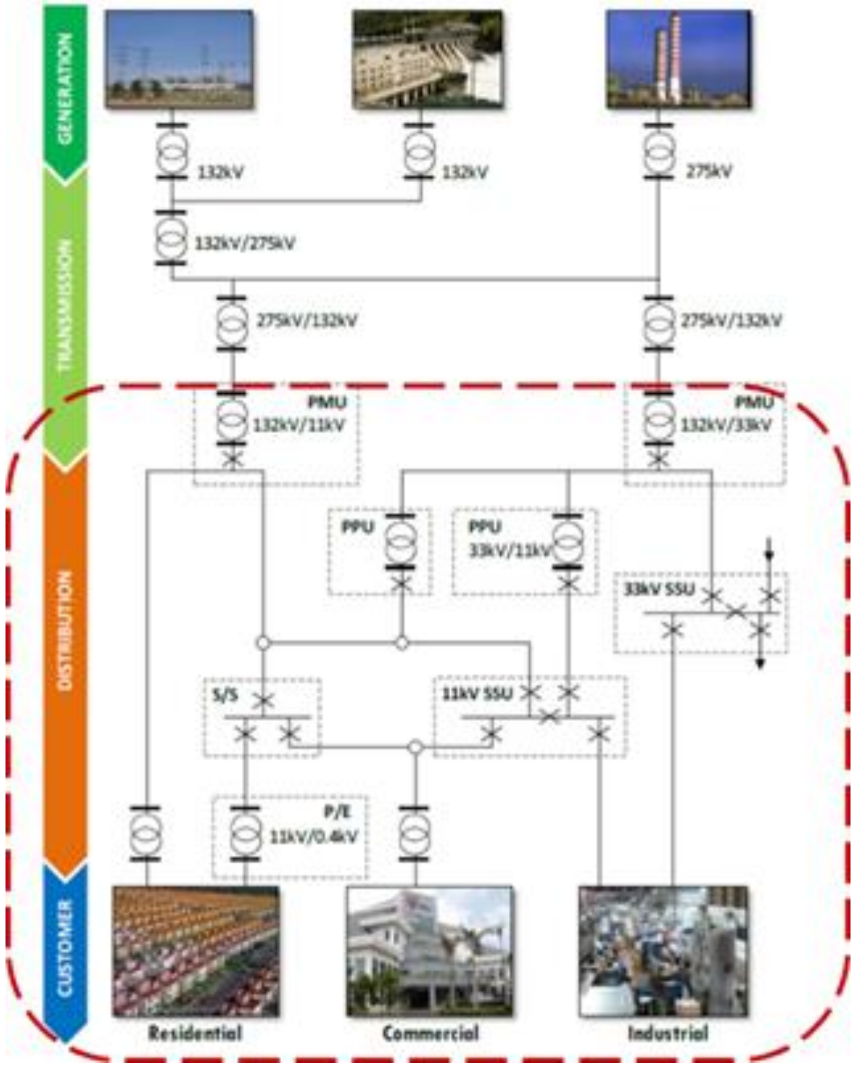

Figure 3. TNB Distribution Electricity Network Level

Besides TNB Distribution, TNB Generation and Transmission are also using GIS. There was incident of GIS TNB Distribution data corrupt that took place in September 2013 due to data deployment by other division. This incident happened due to data model changes. Data has been posted to the working top without proper monitoring by the system administrator and QAQC part. This resulted in data cleansing exercise, validation, verification, rectification and data re- collection and re-digitization to be carried out that involves cost, time, people and effort.

The existing business rules and digitization standards did not improve the edge matching process. This creates slow data entry and backlog of information. Some scenarios seen in the real world are modelled by using workaround e.g. street lighting, parallel feeders etc. Conventional method in data collection where 100% works are from field visit via sketching of network on paper were used due to the slowness of digitizing device used at site. This slow down the data collection period. Data production were carried out through work packages. The disadvantages of using work packages are, the data collected are not completed as full flow circuit Therefore, the data completeness is difficult to achieve. Also, with work packages, the issues of overlap boundaries required data collectors to do edge matching works which can be less accurate. In addition, no data health check was performed due to lack of knowledge in GIS and incompetent staff due to wrong matching of personnel to execute GIS works. Instead, only system health check was carried out by TNB ICT with no proper monitoring by data management unit.

2.3 Business Process

In TNB CGIS Project Review Documents (2014), some of the functions developed exceeded the capability of GE Smallworld software at that time. Ambitious numbers of functions i.e. fifteen (15) that are being developed and deployed with minimal stabilization period. This may contribute to steep learning curve and TNB staff will take time to get accustomed to the new work method. Extensive customization affecting system performance and stability. This is because user wants GIS to replicate their existing work process. This contributed to GIS software product limitation. Extensive data volume and current system architecture may not be able to respond and provide services smoothly. Functionality gaps identified where full work scenarios were not taken into consideration during the development. For example, in Project Planning, the function developed should cover new injection Project, reroute of underground cable, reconfiguration of system and others. Whereas in Asset Register, no module for street lighting new installation and maintenance process were developed.

2.4 User

The incompetency of user in using GIS also contribute to the users' pain in data management. The ability of the user to handle conflict management, delta management is purely individual with few business rules standards. Most of the GIS work is using Core i.e. desktop and office environment with less flexibility. During implementation period there was not enough stabilization period because GIS is totally new software that will change their traditional way of working culture before. Sahay (1998), agreed that this will require time and space for a project to succeed due to cultural and work behaviour. There was no performance measurement carried out to user to measure and support the successfulness and support during the GIS implementation. There was also lack emphasis in people and manpower resourcing.

3. Key Success Factor of GIS Re-Implementation

Key successful factor is important in evaluating a project deliverable whether it is a successful or failure**.** Kandelousi et al. (2011), defined a project is successful if it is delivered on time and within budget, diversely with reference to available literature reviews, there are other various factors such as leadership of Project Manager and Top Management involvement also contribute to the project success. Tsiga et al. (2014) explained that the measurement of success can be categorized into two i.e. project management success and project success where the earlier measured against project performance of initial estimates cost, time and quality whereas the later measured against the overall objectives of a project. For this case study, project success is the project deliverable used for GIS re-implementation.

The re-implementation followed the Project Management Model (PMBOOK Guide, 2013) and using Agile Scrum Method. Agile Scrum Method is implemented because user can improve the delivery time and budget by prioritizing the feature and also early rectification when encountered during the implementation period that resulted high quality product and fulfil customer requirement (Hinde and Adhunashipudimath, 2015). The KSFs criteria are identified and measured from the GIS components and System Usability Scale (SUS) is used for interpreting the KSF outcome. Some of the KSF carried out are through audit, survey, real experience and tracking log.

3.1 System and Tools

Based on the pain points of implementing GIS, the KSF for system is identified by analysing its capability in providing system **Availability** to the user i.e. 24hour x 7days and applications used experienced zero interruption. This action is important in increasing the utilization of GIS. The system must also capable of accommodating the database growth that is proportion to network growth and the increase number of user i.e. **Scalability.** The **Integration** between GIS and SAP ERMS, SCADA and other future legacy software using SOA as bus enterprise must be working correctly and smoothly. For good

System Remediation, the existing data model is revised in order to improve performance and system configuration as well as backup and disaster recovery policy.

3.2 Data

Data health is important in ensuring the posted data is completed and reliable. As mentioned earlier, existing data collected were not completed as a full flow circuit. Measurement of KSF on **Data Completeness** via customer data, asset data, function data and map (using Department of Survey and Mapping, Malaysia cadastral map) are important. D**ata Security** is secured through establishing data governance, data access restriction and data exporting restrictions. While **Data Quality** ensured the existing data are reliable, accurate and correct through verified data integrated via ERMS SAP for equipment number, functional location of asset i.e. Id, Billing and Customer Relation Management (BCRM) for customers and all related field.

3.3 Business Process

KSF is used to measure the business process of the four re-implemented GIS functions. KSF measures the usefulness, adaption and utilization of the GIS functions. The re-implementation strategy must adhere to the Process Standardization and Improvement (PSI) that has been established in TNB Distribution for the four functions and satisfy the user.

The four functions are important in asset registration of existing asset, new asset and existing asset that changes due to operational and maintenance activities. In order to provide complete, current and accurate data, GIS is embedded in the daily work process. The issues that collected earlier and not resolved are monitored and evaluated during the KSF implementation for successful implementation.

3.4 User

A survey is conducted to measure User's Experience and establish satisfaction index in order to measure the acceptance level of user for success re-implementation. The target survey audience are TNB Cheras Users (staff) and GIS Distribution Project Team. The measurement is implemented via online focusing on business functions and data, system, support, training and communication.

4. Results and Discussions

SUS or System Usability Scale is used to establish Final Index Outcome of KSF (Martins, et al., 2015) SUS is used for outcome measurement of KSF as seen in Table 2. It is one of the most efficient ways of gathering statistically valid data and giving the survey data a clear and reasonably precise score. Below are some of the proposed technical data sheets for evaluation of KSF based on the four components of GIS. The meet KPIs are established via 1 for Yes and 0 for No as in Table 3. The measurement is carried out via online survey using share point for the user experience through TNB website, assessed utilization, tracking log checking, audit and realization by walking through the business process.

Table 2 SUS Used in KSF Evaluation Interpretation

Survey Percentage	Score Interpretation
>80% ~ 100	Excellent.User like the system and will recommend to their friends (TNB Staff)
>70% ~<80%	Favourable but could be improved
<= 70%	Mitigation plan required to improve

Table 3 Few Samples of Technical Evaluation Data Sheet of GIS Components

No	Type	Sub-type	System Category (Factors)	Question	Meet KPI (1 - Yes, 0 - No)
1	System	Availability	>=99.8% Availability of TNB GIS applications (Core)	Application usage without interruption	
2		Scalability	Scalability - Core	Ability to handle the database growth	
3	Data	Data Completeness	Asset Information available in the system (in sync with ERMS-PM)	>=90% of asset count available in TNB GIS compared to ERMS	
4			(G100) To identify object without child (i.e. Transformer without fuse or demand point without account no)	Completed/In Progress	
5	Business Function	SNC	(G100) Need enhancement to perform other scenarios (i) existing supply upgrading (ii) LV system improvement (iii) Street lighting application	Completed/In Progress	
6			Ability to identify the nearest source of supply in GMSC Mobile	Completed/In Progress	
7	User	Business Function/ Data	I understand the GIS functions usage (eg : AR, SNC, CPP, CSS - Smartview) in my daily work.	Satisfied/Not Satisfied	

Results from the KSF is shared in Figure 4. The percentage figures collected at each GIS components are derived using average or mean score of satisfaction. The KSF interpretation in Table 2, indicated that the re-implementation of GIS in Cheras is excellent and user like using the system and will recommend it to their friends i.e. TNB Staff. The GIS Distribution Project team need to focus in improving the scoring for User because Rodríguez-Segura, E. et al. (2016) claimed that the Client and user is considered the most important and relevant KSF to succeed beside the project environmentand and robust project management.

Figure 4. The measurement outcome of KSF

5. Conclusion

The strategize activities are developed and implemented based on the improvement of the pain point discussed in the critical discussion above. These activities are re-implemented by focusing on the four GIS components which are System and Tools, Data, Business Process and User. The KSF used to measure the success of the project is a good and simple method. The KSF interpretation outcome convinced the top management on the success of the project. Upon project progress update to the top management, they have decided for GIS re-implementation to be rolled out to other TNB Distribution stations.

References

Cico, Z., Salihbegovic, A., Gegic, O. & Heljic, J. (2015). Implementation of Enterprise GIS in Power Distribution, *25th International Conference on Information, Communication and Automation Technologies, ICAT Proceedimgs.*

Hinde, S. H. A. S. & Adhunashipudimath, M. (2015). *Analysis of Agile Project Management with Scrum Method and Extreme Programming*. 4(13): 2465–2471.

Ian, H., Cornelius, S. & Carver, S. (2006). An Introduction to Geographical Information Systems (3rd ed). Harlow, Essex: Pearson Education.

Kandelousi, N. S., J., O. & A, A. (2011). 'Key success factors for managing projects'. 5(11): 1292–1296. Available at: http://www.waset.org/Publications/key-success-factors-for-managing-projects/8740.

Meehan, B. (2013). Modelling electric Distribution with GIS. Redlands, California: Esri Press.

Martins, A. I., Rosa, A. F., Queirós, A., Silva, A. & Rocha, N. P. (2015). European Portuguese Validation of the System Usability Scale (SUS). *Procedia Computer Science.* 67(Dsai): 293–300.

PMBOOK guide. (2013). A guide to the Project Management Body of Knowledge. (5th ed). Newton Square, PA, United States.

Rodríguez-Segura, E., Ortiz-Marcos, I., Romero, J. J. & Tafur-Segura, J. (2016) 'Critical success factors in large projects in the aerospace and defense sectors', *Journal of Business Research. Elsevier Inc.*, 69(11): 5419–5425.

Shamsi, U.M. (2004). GIS Applications for Water Distribution Systems. *Journal of Water Management Modeling*. R220-21.

Sahay, S. (1998). Implementing GIS technology in India: Some issues of time and space. *Accounting, Management and Information Technologies*. 8(2–3): 147–188.

Tomlinson, R. (2013). Thinking about GIS: Geographic Information System Planning for Managers. Redlands, California: Esri Press.

TNB. December 2016, TNB Homepage Website. Retrieved from https://www.tnb.com.my/

TNB. (2008). TNB's 10 years GIS Master Plan

TNB. (2014). TNB CGIS Project Review Documents.

Tsiga, Z., Emes, M. & Smith, A. (2017) 'Critical success factors for projects in the petroleum industry', *Procedia Computer Science. Elsevier B.V.* 121: 224–231.